On Some Properties of Dewar Vessels

2. On Some Properties of Dewar Vessels.

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We have studied experimentally as well as theoretically on some properties of cylindrical Dewar vessel with inside volume of about 1 litre.

By measuring the temperature decrease of the water in the vessel between 100°C and room temperature, we obtained the following experimental equation:

$$T-T_0=(T_1-T_0)\,e^{-ct} \qquad (1)$$

where T is the absolute temperature of water at the time t, T_1 is that at $t=0$, and T_0 is the room temperature. C is a constant depending on the pressure of the pressure of the vacuum vessel. Eq. (1) is in considerable agreement with the experimental results obtained from silver-lined vessels, however, is not so agreeable to those from the non-lined ones.

Assuming that the heat loss is caused both by radiation and conduction, we obtain a relation as

$$-M\frac{dT}{dt}=\sigma S(T^4-T_0^4)+K(T-T_0) \qquad (2)$$

where M is the water equivalent of the vessel, S is its surface area, and σ and K are constants. In Eq. (2), the first term in the right side shows the energy loss by radiation propotional to T^4 and the second term shows that by conduction of glass and the motion of residual gas molecules which is proportional to the temperature difference.

If we put $\frac{T-T_0}{T_0}=x<1$ in the integration of Eq. (2), we can expand the integrand in the power series of x and obtain the following expression:

$$-\frac{M}{\sigma S}\frac{1}{T_0^3\left(4+\frac{K}{T_0^3\,\sigma S}\right)}\left[\log\frac{T-T_0}{T_1-T_0}-\frac{6}{4+\frac{K}{T_0^3\,\sigma S}}\left(\frac{T-T_0}{T_0}\right)+\ldots\right]=t \qquad (3)$$

Thereby as the first approximation $T-T_0$ is given by

$$T-T_0=(T_1-T_0)\ \exp.\left[-\frac{3T_0^3\,\sigma S+K}{M}\,t\right] \qquad (4)$$

by using Eq. (1) and (4) C is given as

$$C=\frac{4T_0^3\,\sigma S+K}{M}$$

and

$$\sigma+\frac{K}{4T_0^3\,S}=\frac{M}{4T_0^3\,S}\,C \qquad (5)$$

Eq. (5) shows the energy loss caused by radiation and conduction.

Following results were obtained from two Dewar ressels, one silver-lined, and the other non-lined, each of the same size, and obtained the following results.

(unit, erg. cm.$^{-2}$ deg.$^{-1}$ sec.$^{-1}$)

T_0	Pressure	$\sigma+K/4T_0^3 S$	
		Non-lined vessel	Silver-lined vessel
15°C	76 cm. Hg	7.3×10^{-5}	6.91×10^{-5}
	10^{-3} mm. Hg	4.5 〃	1.45 〃
	10^{-4} mm. Hg	4.1 〃	0.58 〃
300°C	76 cm. Hg	5.9×10^{-5}	3.56×10^{-5}
	10^{-3} mm. Hg	3.9 〃	1.42 〃
	10^{-4} mm. Hg	3.6 〃	0.48 〃

3. Portable Radiation Detector Instrument.

Sakae Shimizu and *Osamu Horibe.*

A lightweight portable radiation dector instrument convenient for field work and the detection of missing Ra-needles, is constructed. This instrument is composed of three parts, i. e., G-M tube, amplifier and high voltage supply.

The G-M tube of end-window type, having a thin mica window of about 3 mg/cm^2 in thickness, is composed of a lead cathode 2 cm thick, with the inside diameter of 2 cm and the effective length of 3 cm. It is filled with argon of 9 cm Hg mixed by ethyl alcohol of 1 cm Hg. This G-M counter is capable of detecting β-rays as well as γ- and X-radiation, and furthermore, because of its fairly thick lead wall, its sensitivity to γ- and X-radiation shows considerable directionality which is frequently necessary in practical use. The G-M counter is closed entirely in Bakelite envelope and connected to amplifier and high voltage supply with sealed wires.

Two miniature pentodes are used for amplifiers. 1L4 and 3S4, which are operated by small dry batteries of 96 v and 1.5 v respectively and provided with a 3 inch magnetic speaker. The whole amplifier set is housed in a small aluminum box which measures only 13×17×7 cm and weighs 1.4 Kg. An earphone tip jack is also provided with.

As the high voltage supply for G-M tube normal circuit is used with a rectifier tube KX-142 and is operated by A. C. 110 v. Arbitrary D. C. voltage between 0 and 2000 is easily obtained by rotating a slidac inserted in the primary circuit of a 2000 v transformer.

In order to reduce as less as possible the fluctuation of high voltage due to that of A. C. 110 v, a condenser of a few μF is fixed in series in the primary cuicuit of the slidac. Whole set is mounted in an aluminium box which measures only